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Antibiotic Resistant Bacteria and Resistance Genes in Crop Fields

Abstract

Antimicrobials are added to swine feed or water to boost the daily growth of pigs and reduce animal death rates at swine facilities, thereby enhancing overall production efficiency and increasing profitability. Tylosin is among the most widely used of the macrolide class of veterinary antibiotics by the swine industry. This study is being conducted over multiple years to examine the fate and transport of antibiotic resistant bacteria (ARB) from fields receiving swine manure application to tile drainage systems.

Keywords

Agricultural and Biosystems Engineering

Disciplines

Agricultural Science | Agriculture | Bioresource and Agricultural Engineering

Antibiotic Resistant Bacteria and Resistance Genes in Crop Fields

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Introduction

Antimicrobials are added to swine feed or water to boost the daily growth of pigs and reduce animal death rates at swine facilities, thereby enhancing overall production efficiency and increasing profitability. Tylosin is among the most widely used of the macrolide class of veterinary antibiotics by the swine industry. This study is being conducted over multiple years to examine the fate and transport of antibiotic resistant bacteria (ARB) from fields receiving swine manure application to tile drainage systems.

Materials and Methods

Eight plots were sampled at the ISU Northeast Research Farm, Nashua, Iowa. These agricultural plots are instrumented with a subsurface water quality monitoring system operational since 1988. Each one-acre plot is drained separately with subsurface drain lines installed in the center of the plot. The plots encompass two tillage practices: chisel plow and no-till, and liquid swine manure was injected on one of each tillage type while the second of each type received urea ammonium nitrate (UAN) and served as a control for assessing background levels. A summary of the plots selected for sampling is presented in Table 1.

Following manure application, composite soil samples were collected from each manure

plot, three from the manure band and three from the area between the manure bands. Three samples also were collected from the control plots. A second set of soil samples was collected the following April from the same locations. Water samples were collected on a weekly basis and following major rainfall events while tile lines were flowing.

Results and Discussion

Enterococci were present in liquid swine manure, with concentrations ranging from 14,462 cfu/g to 565,706 cfu/g over the four-year study. Percentages of tylosin resistant enterococci in manure samples ranged from 54–100 percent in the study. In soil, enterococci concentrations were the greatest in the manure injection band and the lowest in the no-manure (control) plots.

Enterococci concentrations in tile water were highly variable relative to time after manure application (Figure 1) and drainage flow rate (data not shown). Enterococci concentrations were expected to be highest at the start of tile flow and decrease over the growing season. However, there was no correlation ($r < 0.5$) between enterococci concentrations relative to drainage flow or time after manure application witnessed during the study in tile flow (Figure 1). There also was no statistical difference in the concentration of enterococci in tile water due to manure application.

Tylosin-resistant enterococci in the tile water were rarely detected. Percentages of tylosin-resistant enterococci ranged from 2–16 percent of total enterococci concentrations in the tile water samples collected over the four-year period.

Conclusions

In four years of study, concentrations of enterococci in tile water were very low and rarely exceeded the geometric mean for recreational waters. Correlations were not found between manure application to agricultural soils and concentrations of enterococci in tile water. Future work is recommended to capture the event hydrograph for better assessment of land management practices on contaminant transport during precipitation events.

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Table 1. Plots selected for sample collection, including ID numbers, crop, tillage practice, and nutrient management history at the ISU Northeast Research Farm, Nashua, IA.

Plot	Tillage ¹	Nitrogen management ²
23	CP	2010 & 2012 Fall inject swine manure at 168 kg N/ha
24	CP	Spring preplant spoke inject UAN at 168 kg N/ha
25	NT	2010 & 2012 Fall inject swine manure at 168 kg N/ha
34	NT	Spring preplant spoke inject UAN at 168 kg N/ha with cover crop
29	CP	Spring preplant spoke inject UAN at 168 kg N/ha
30	CP	2011 & 2013 Fall inject swine manure at 168 kg N/ha
19	NT	Spring preplant spoke inject UAN at 168 kg N/ha with cover crop
20	NT	2011 & 2013 Fall inject swine manure at 168 kg N/ha

¹CP = chisel plow; NT = no-till.

²168 kg N/ha = 150 lb/acre.

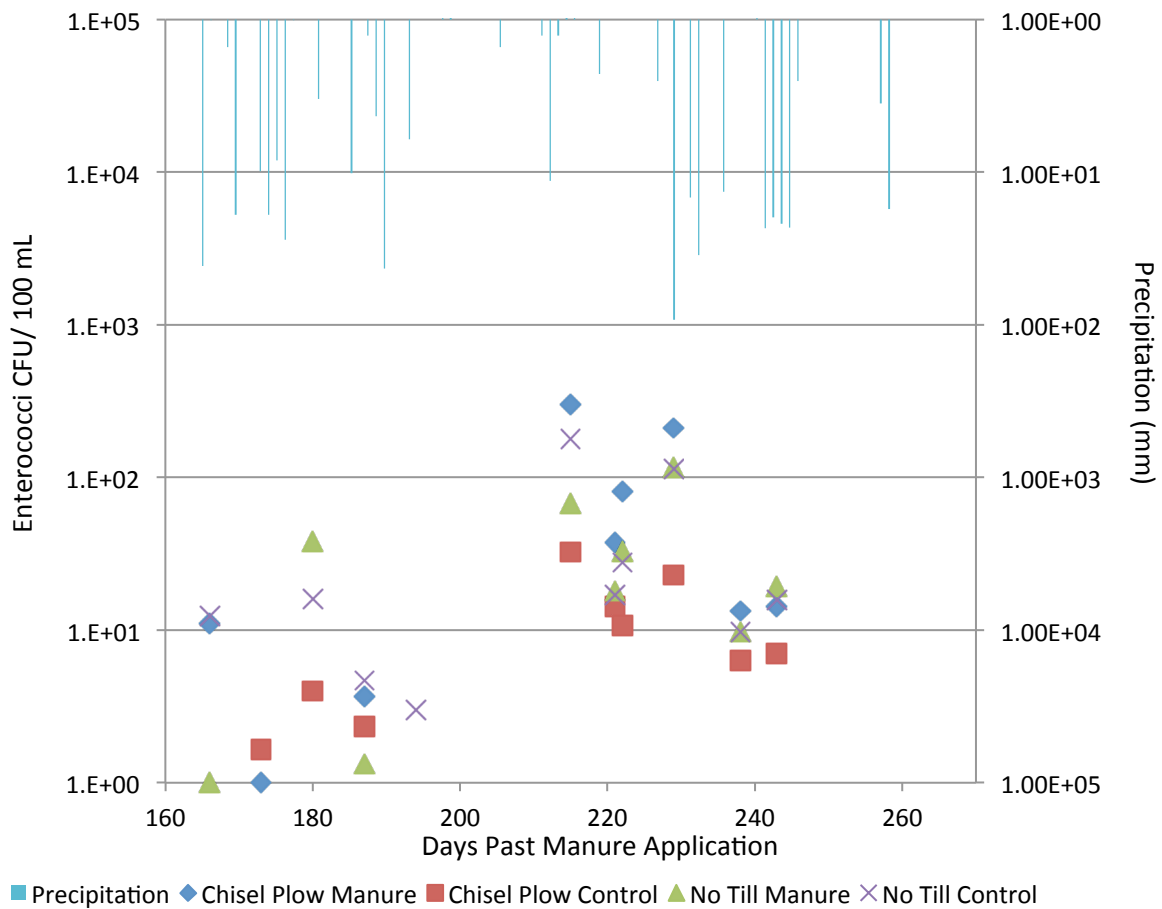


Figure 1. Enterococci in individual tile water samples in the first growing season after manure application in 2014.